Serial No. 10/766,035
Docket No. F03-363-US
Ref. No. FUJIT.064

AMENDMENTS TO THE CLAIMS:

1. (currently amended) An edge-emitting type semiconductor laser in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

a substrate;

an n-type contact layer formed on or above said substrate; ~~and~~

an active layer formed on or above said n-type contact layer; <u>and</u>

<u>a concave part or cavity part formed at least a part right under said laser cavity;</u>

wherein ~~thickness of at least a part of~~ said n-type contact layer <u>has a thinner portion formed of at least a part</u> ~~which is~~ right under said laser cavity <u>and a thicker portion except for said thinner portion, and a thickness of said thinner portion</u> is thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda,(n^2-n_{ep}{}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength in said active laser;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ.

2. (canceled)

3. (currently amended) An edge-emitting type semiconductor laser according to claim [[2]] 1, wherein said [[a]] concave part or said [[a]] cavity part is formed by evaporating at least a portion of said semiconductor layer which is placed right under said laser cavity by laser irradiation.

4. (original) An edge-emitting type semiconductor laser according to claim 1, comprising:

a concave part which reaches said n-type contact layer from the back surface of said crystal growth substrate and exists at least right beneath said laser cavity.

5. (currently amended) An edge-emitting type semiconductor laser in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

an n-type contact layer having a thinner portion formed at least a part right under said laser cavity and a thicker portion except for said thinner portion; and

a concave part which is formed at the bottom of said laser cavity by removing said crystal growth substrate and said semiconductor layer existing at least right beneath said laser cavity from the back surface of said crystal growth substrate; wherein

a removing process is carried out until a thickness of said thinner portion of said ~~an~~ n-type contact layer becomes thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda(n^2-n_{ep}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength of an active layer;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ.

6. (currently amended) An edge-emitting type semiconductor laser ~~according to claim 2~~ in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

a substrate;

an n-type contact layer formed on or above said substrate;and

an active layer formed on or above said n-type contact layer;

wherein a thickness of said thinner portion is thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda,(n^2-n_{ep}{}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength in said active laser;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ, and

wherein a concave part or a cavity part is formed at least a part right under said laser cavity;

the semiconductor laser further comprising an n-type clad layer wherein a dielectric film or a semiconductor film having smaller refractive index than that of said n-type clad layer is formed at the bottom of said n-type contact layer exposed in said concave part.

7. (currently amended) An edge-emitting type semiconductor laser ~~according to claim 5~~ in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

a concave part which is formed at the bottom of said laser cavity by removing said crystal growth substrate and said semiconductor layer existing at least right beneath said laser cavity from the back surface of said crystal growth substrate; wherein

a removing process is carried out until a thickness of an n-type contact layer becomes thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda(n^2 - n_{ep}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength of an active layer;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ;

said semiconductor laser further comprising an n-type clad layer wherein a dielectric film or a semiconductor film having smaller refractive index than that of said n-type clad layer is formed at the bottom of said n-type contact layer exposed in said concave part.

8. (original) An edge-emitting type semiconductor laser according to claim 4, wherein a metal layer or a metal part is formed in at least one portion or the entire portion of said concave part.

9. (original) An edge-emitting type semiconductor laser according to claim 5, wherein a metal layer or a metal part is formed in at least one portion or the entire portion of said concave part.

10. (original) An edge-emitting type semiconductor laser according to claim 8, wherein a negative electrode is formed by using said metal layer or said metal part.

11. (original) An edge-emitting type semiconductor laser according to claim 9, wherein a negative electrode is formed by using said metal layer or said metal part.

12. (currently amended) An edge-emitting type semiconductor laser ~~according to claim 1~~ in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

a substrate;

an n-type contact layer formed on or above said substrate; and

an active layer formed on or above said n-type contact layer; wherein

a thickness of at least a part of said n-type contact layer which is right under said laser cavity is thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda(n^2 - n_{ep}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength of an active layer;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ;

and wherein the semiconductor laser further comprises:

a negative electrode formed on the exposed surface of said n-type contact layer whose upper surface is exposed through etching treatment from the upper side of said plural semiconductor layers; and

a semiconductor layer comprising a p-type or undoped Group III nitride compound semiconductor formed between said n-type contact layer and said crystal growth substrate.

13. (currently amended) An edge-emitting type semiconductor laser ~~according to claim 4~~ in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

a substrate;

an n-type contact layer formed on or above said substrate;and

an active layer formed on or above said n-type contact layer;

wherein a thickness of at least a part of said n-type contact layer which is right under said laser cavity is thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda,(n^2-n_{ep}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength in said active laser;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ;

said semiconductor laser further comprising:

a concave part which reaches said n-type contact layer from the back surface of said crystal growth substrate and exists at least right beneath said laser cavity;

a negative electrode formed on the exposed surface of said n-type contact layer whose upper surface is exposed through etching treatment from the upper side of said plural semiconductor layers; and

a semiconductor layer comprising a p-type or undoped Group III nitride compound semiconductor formed between said n-type contact layer and said crystal growth substrate.

14. (currently amended) An edge-emitting type semiconductor laser ~~according to claim 5~~ in which a laser cavity is formed by depositing plural semiconductor layers on a crystal growth substrate, comprising:

a concave part which is formed at the bottom of said laser cavity by removing said crystal growth substrate and said semiconductor layer existing at least right beneath said laser cavity from the back surface of said crystal growth substrate; wherein

removing process is carried out until thickness of an n-type contact layer becomes thinner than a value Λ of a function of a luminous wavelength λ, determined by the formula

"$\Lambda = f(\lambda) = \lambda(n^2 - n_{ep}^2)^{-1/2}/2$"

in which λ, n, and n_{eq} are represented by:

luminous wavelength of an active layer;

refractive index of said n-type contact layer which depends on said luminous wavelength λ; and

equivalent refractive index of said n-type contact layer in guided wave mode which depends on said luminous wavelength λ,

a negative electrode formed on the exposed surface of said n-type contact layer whose upper surface is exposed through etching treatment from the upper side of said plural semiconductor layers; and

a semiconductor layer comprising a p-type or undoped Group III nitride compound semiconductor formed between said n-type contact layer and said crystal growth substrate.

15. (original) An edge-emitting type semiconductor laser according to claim 1, wherein thickness of said n-type contact layer at the part right beneath said laser cavity is in a range from $\Lambda/5$ to less than Λ.

16. (original) An edge-emitting type semiconductor laser according to claim 4, wherein thickness of said n-type contact layer at the part right beneath said laser cavity is in a range from $\Lambda/5$ to less than Λ.

17. (original) An edge-emitting type semiconductor laser according to claim 3, wherein thickness of said n-type contact layer at the part right beneath said laser cavity is in a range from $\Lambda/5$ to less than Λ.

18. (original) An edge-emitting type semiconductor laser according to claim 5, wherein thickness of said n-type contact layer at the part right beneath said laser cavity is in a range from $\Lambda/5$ to less than Λ.

19. (original) An edge-emitting type semiconductor laser according to claim 1, wherein a distributed feedback structure (DFB structure), which oscillates lights along a resonance direction of said laser cavity, is formed at at least a portion of the bottom of said n-type contact layer placed right under said laser cavity.

20. (original) An edge-emitting type semiconductor laser according to claim 19, wherein thickness of said n-type contact layer at the part right beneath said laser cavity is in a range from $\Lambda/5$ to less than Λ.